CALIFORNIA DIVISION OF MINES AND GEOLOGY

Fault Evaluation Report FER-40

September 30, 1977

1. Name of fault: Red Hill fault.

2. Location of fault: Cucamonga Peak, Guasti, and Ontario 7½' minute quadrangles, San Bernardino County (figure 1).

3. Reason for evaluation: This fault is located within the 1977 study area of the 10-year program for fault evaluation. The map of Morton (1976) shows a segment of the fault trace as a scarp in "Holocene" alluvium. Burnham (1953, plate 1) shows the same fault trace segment as "exposed fault" cutting "Recent" alluvium.

4. List of references:

Burnham, W.L., 1953, The geology and ground water conditions of the Etiwanda-Fontana area, California: unpublished Masters thesis, Claremont College, Claremont, California, 136 pages. Plate I scale 1:31,680.

(He gives a rather specific written description of the ground water barrier, and plots it on a 1:31,680 map (plate I). He shows the northeasternmost 1.2 km segment of the fault cutting "Recent" alluvium.)

California Department of Water Resources, 1970, Meeting water demands in the Chino-Riverside area: California Department of Water Resources Bulletin 104-3, Appendix A: Water Supply, 108 p. Map scale 1:127,000.

(Plate 4 shows the fault as a solid line wrapping around Red Hill, but the text does not substantiate the use of a solid line.)

Eckis, Rollin, 1928, Alluvial fans of the Cucamonga district, southern California: Journal of Geology, v. 36, no. 3, p. 224-247. Map scale about 1:160,000.

(He is the first person to speculate that the southern side of Red Hill may be fault bounded, but he does not show the fault on his map.)

Eckis, Rollin, 1934, South coastal basin investigation, geology and ground water storage capacity of valley fill: California Division of Water Resources Bulletin 45, 279 p. Maps A, C, and E. Scale about 1:150,000.

(His Plate C is the first map to show the Red Hill fault. He mentions an "escarpment" along the southern and southeastern sides of Red Hill.)

Fife, D.L., D.A. Rodgers, G.W. Chase, R.H. Chapman, and E.C. Sprotte, 1976, Geologic hazards in southwestern San Bernardino County, California: California Division of Mines and Geology Special Report 113, 40 p. Map scale 1:48,000.

(They say nothing about the Red Hill fault, but show it on plate 1A. It is compiled from the unpublished mapping of D.M. Morton.)

Jennings, C.W., 1975, Fault map of California with locations of volcanoes, thermal springs and thermal wells: California Division of Mines and Geology, California Geologic Data Map Series, Map no. 1. Scale 1:750,000.

Morton, D.M., 1976, Geologic map of the Cucamonga fault zone between San Antonio Canyon and Cajon Creek, San Gabriel Mountains, southern California: U.S. Geological Survey Open File Report 76-726. Scale 1:24,000.

(His map shows the northeasternmost 1.2 km of the fault cutting "Holocene" alluvium.)

Morton, D.M., 1977, Annotation added to the map of Open File Report 76-726: personal communication.

Real, C.R., and Cramer, C., 1977, Seismicity near Cucamonga fault, 1932 to 1976: California Division of Mines and Geology, unpublished maps and memorandum. Map scale 1:250,000.

5. Summary of available data:

The Red Hill fault is a hyperbola-shaped feature that "wraps around" Red Hill, a low hill with about 60 m of relief that lies about 2 km west-northwest of the community of Cucamonga in westernmost San Bernardino County (see figure 5). Most of the fault is located on the basis of a fairly well-defined subsurface water barrier (Eckis, 1934, p. 189; Burnham, 1953, p. 54; and Department of Water Resources, 1970, p. 11). Eckis (1934, p. 189) mentions an "escarpment" along the southern and southeastern sides of Red Hill, but does not elaborate on the nature of the escarpment. Both Burnham (1953) and Morton (1976) map a scarp in alluvium just west of East Etiwanda Wash. Burnham shows this scarp as being the northeasternmost 1.2 km of the Red Hill fault.

None of the references give any description of the scarp. No other surface features indicative of a fault trace are mentioned; only evidence for the existence and location of the subsurface water barrier is given. The Department of Water Resources (1970, p. 11) makes the following statement regarding the relationship of Red Hill to the fault: "Subsurface data ... clearly indicate that the hill is the result of upward movement on the north side of a peculiar, flap-like fault that curves around the base of the hill." However, the data in the report seem only to support the water barrier, and do not indicate the sense and magnitude of displacement that has occurred along the fault that the water barrier is presumed to represent. D.M. Morton (personal communication, 10/7/77) stated that he knows of no topographic features indicative of a fault trace for the Red Hill fault except for the 1.2 km scarp at the northeastern end. However, the existence of Red Hill, which is composed of older alluvium and surrounded by younger alluvium, implies the existence of the fault. Red Hill could also be regarded as being only an erosional remnant of some former cycle of alluviation and dissection. Eckis (1928) considered this possibility, but decided, on the basis of bedding altitudes and fan gradient evidence, that the hill was probably caused by uplift along a fault that passes along its southern side.

Well-log sections (CDWR, 1970, sections G-G' on plate 9 and H-H' on plate 10) show the Red Hill fault as a vertical fault with the northern side upthrown. They do not indicate the age of the youngest material that is faulted in the subsurface, but it is implied that much of the faulted strata is Pleistocene age. They show the water table offset by about 120 m in October, 1960 with the northern side up.

The water table on the northern side of the fault was about 60 m below the surface at that time. Their well-data, however, do not really give any information regarding the attitude of the fault plane; the vertical depiction of the fault is probably just a matter of convention in drafting the section. The only other reference that gives any information on the attitude of the fault is Eckis (1928, pl. D). His cross section OP shows the fault dipping about 65 degrees north, and shows the alluvium-basement contact offset about 60 m with the northern side up. The well data used by both of the above references are from widely separated wells (typically several kilometers between wells) and do not strongly substantiate the positions of the eastern and western segments of the fault. It was probably an assumption on the part of the references that the subsurface water barrier lined up with the 1.2 km-long scarp that crosses Etiwanda Avenue to the northeast.

The sense of movement on the fault has almost certainly been north side up (with a possible lateral component). Both the south-facing scarp at the northeastern end of the fault and the apparent uplift of Red Hill to the north of the fault support this assumption.

Only one reference discusses the recency of the fault. Burnham (1953, p. 55) says: "The last movement on this fault can be no older than the Younger Alluvium north of Etiwanda, but it is old enough so that the remainder of its surface trace has been erased by the recent activity of the combined Deer-Day creeks (sic)." On page 17 and on his map (plate 1) he refers to the "Younger Alluvium" as being "Recent" in age. He does not define his usage of the term. None of the references describe the morphology of, or give the height of the scarp at the northeastern end of the fault. D.M. Morton (personal communication,

10/7/77) stated that the geomorphology of the scarp at the northeastern end of the Red Hill fault is similar to the younger-appearing scarps of the Cucamonga fault. He, therefore, believes that movement along this scarp is as recent as along the Cucamonga fault: about 700 years since the last event (see FER-39).

The seismicity maps (figures 2 and 3) show the distribution of earthquake epicenters in this region since 1932 (Real and Cramer, 1977). The epicenters on the 1932-1973 map (figure 2) show a distinct clustering a few kilometers north of the Red Hill fault, whereas they are noticeably sparse within several kilometers to the south of the fault. If the Red Hill fault dips 30 to 60 degrees north like the Cucamonga fault, then the cluster of epicenters to the north of the fault may represent hypocenters on the fault. The 1974-1976 epicenters (figure 3) show no pattern related to the Red Hill fault. It must be borne in mind, however, that these epicenter locations (combined A and B quality) have an error range of about plus or minus 5 km.

6. Interpretation of aerial photos: None.

7. Field observations: None.

8. Conclusions:

Based on the references, only the northeasternmost 1.2 km of the fault meets our criteria for being sufficiently active and well-defined. None of the rest of the fault meets any criterion for either of those two requirements, except, possibly, in the area of contradictory mapping just south of Red Hill.

9. Recommendations:

I tentatively recommend the zoning of the northeasternmost 1.2 km of the fault (see figure 5a). I would like to do a brief aerial photo and ground study of the fault zone. If that yields no definite evidence for the location of and Holocene displacement along the rest of the fault, then I will recommend against zoning any more of the fault.

10. Investigating geologist's name; date:

Drew P. Smith

DREW P. SMITH
Geologist
September 30, 1977

I agree with your recommendations re further work and possible zoning. Please give this a high priority. Before we zone this fault (NE scarp segment) the evidence for "sufficiently active & well-defined" must be verified on photos and/or in the field. This policy applies to all faults recommend for zoning.

CAHA
11/3/77

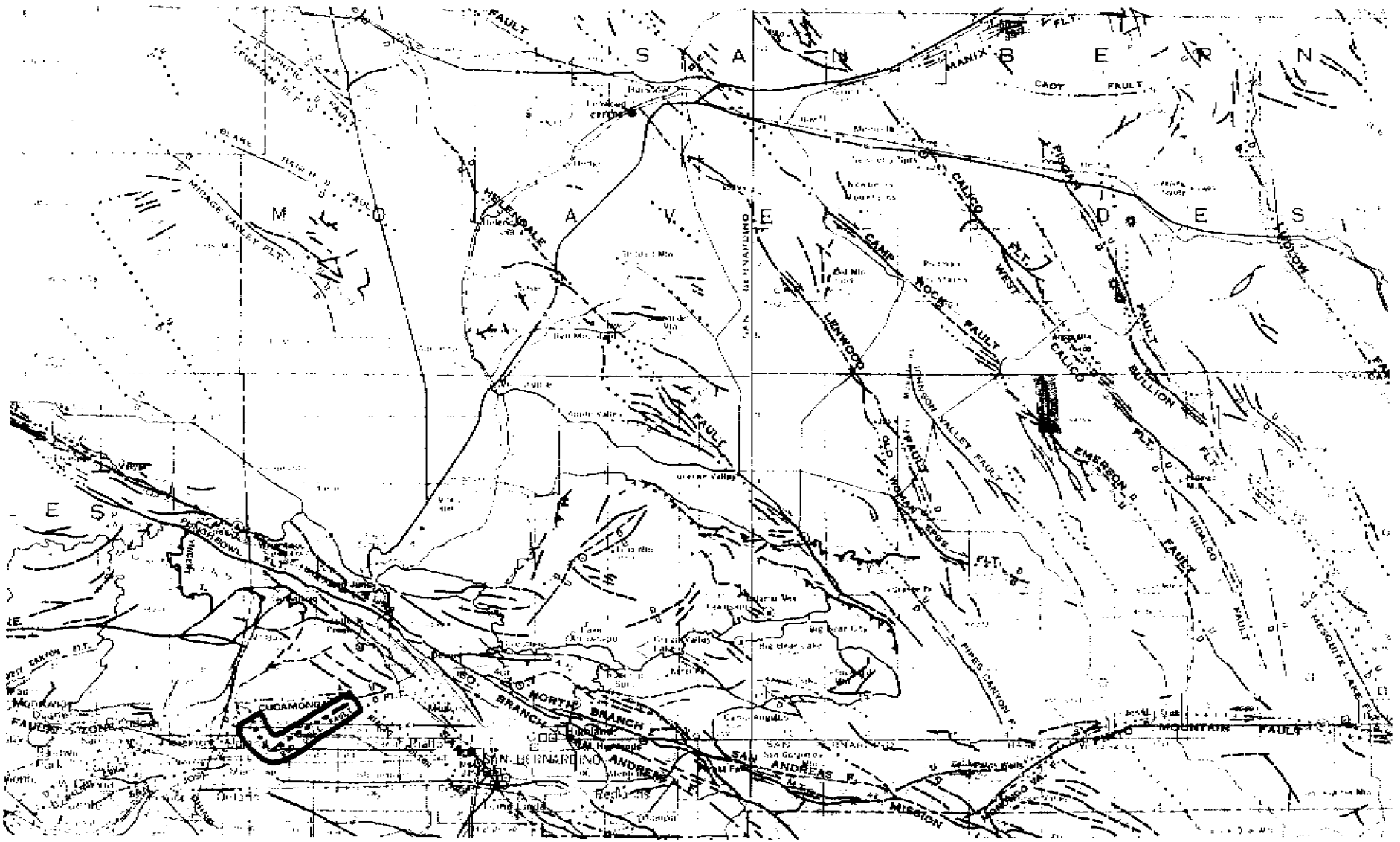


Figure 1. Index map showing location of the Red Hill fault. Map is modified from Jennings (1975).

SEISMICITY NEAR CUCAMONGA FAULT 1932--1973

TRANSVERSE MERCATOR PROJECTION

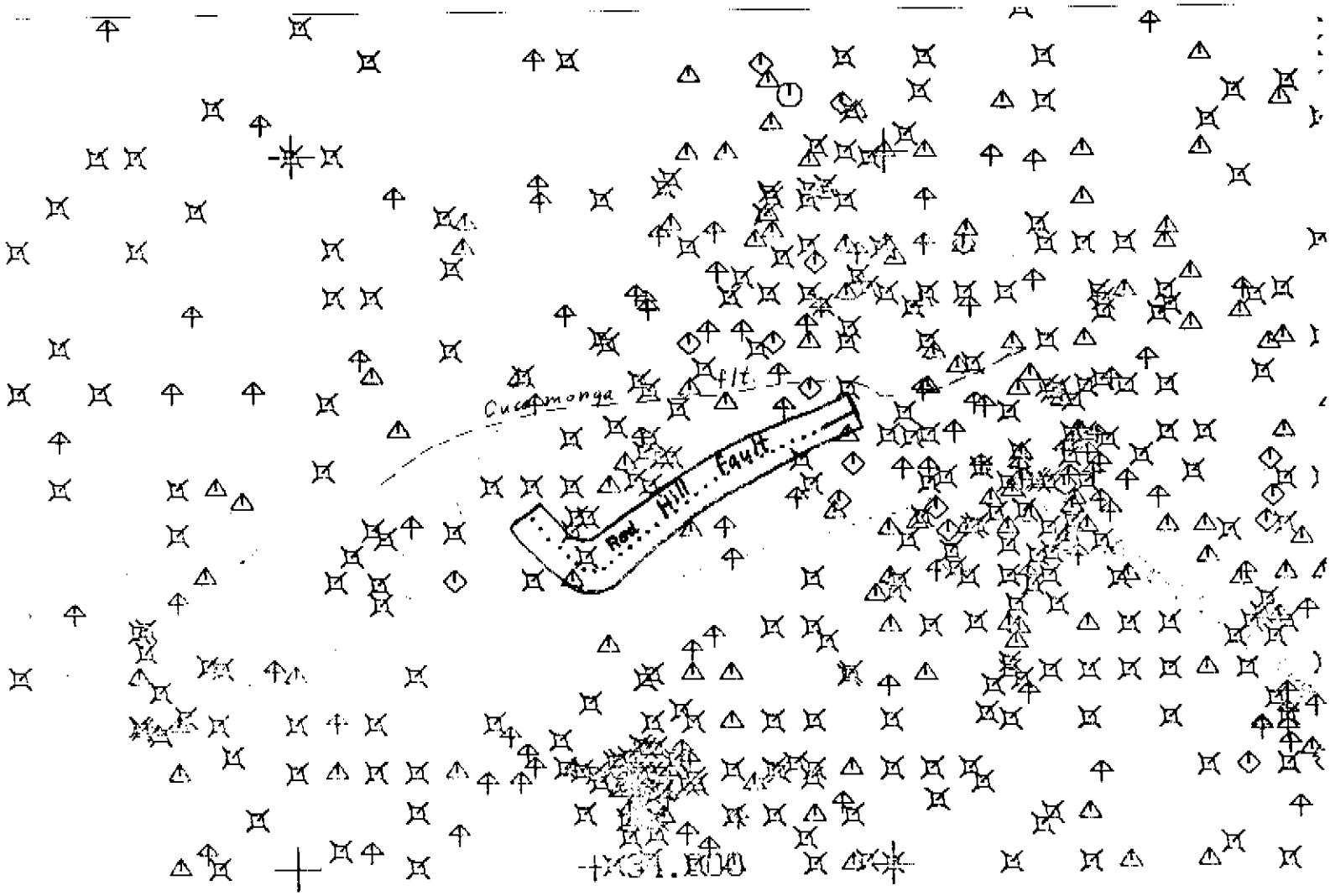
Scale 1:250,000

5 0 5 10 15 20 Statute Miles

5 0 5 10 15 20 25 30 Kilometers

CONTOUR INTERVAL 200 FEET
WITH SUPPLEMENTARY CONTOURS AT 100 FOOT INTERVALS

1.0 .LE. MAG .LE. 1.9
2.0 .LE. MAG .LE. 2.9
3.0 .LE. MAG .LE. 3.9
4.0 .LE. MAG .LE. 4.9
5.0 .LE. MAG .LE. 5.9



117.750 117.625 117.500

Figure 2. Seismicity map (modified from Kiland Crouse 1977).

SEISMICITY NEAR CUCAMONGA FAULT 1974-1976

TRANSVERSE MERCATOR PROJECTION

Scale 1:250,000

5 0 5 10 15 20 Statute Miles

5 0 5 10 15 20 25 30 Kilometers

CONTOUR INTERVAL 200 FEET
WITH SUPPLEMENTARY CONTOURS AT 100 FOOT INTERVALS

Z ..... MAG .EQ. 0.0
✢ ..... 1.0 .LE. MAG .LE. 1.9
⌑ ..... 2.0 .LE. MAG .LE. 2.9
△ ..... 3.0 .LE. MAG .LE. 3.9

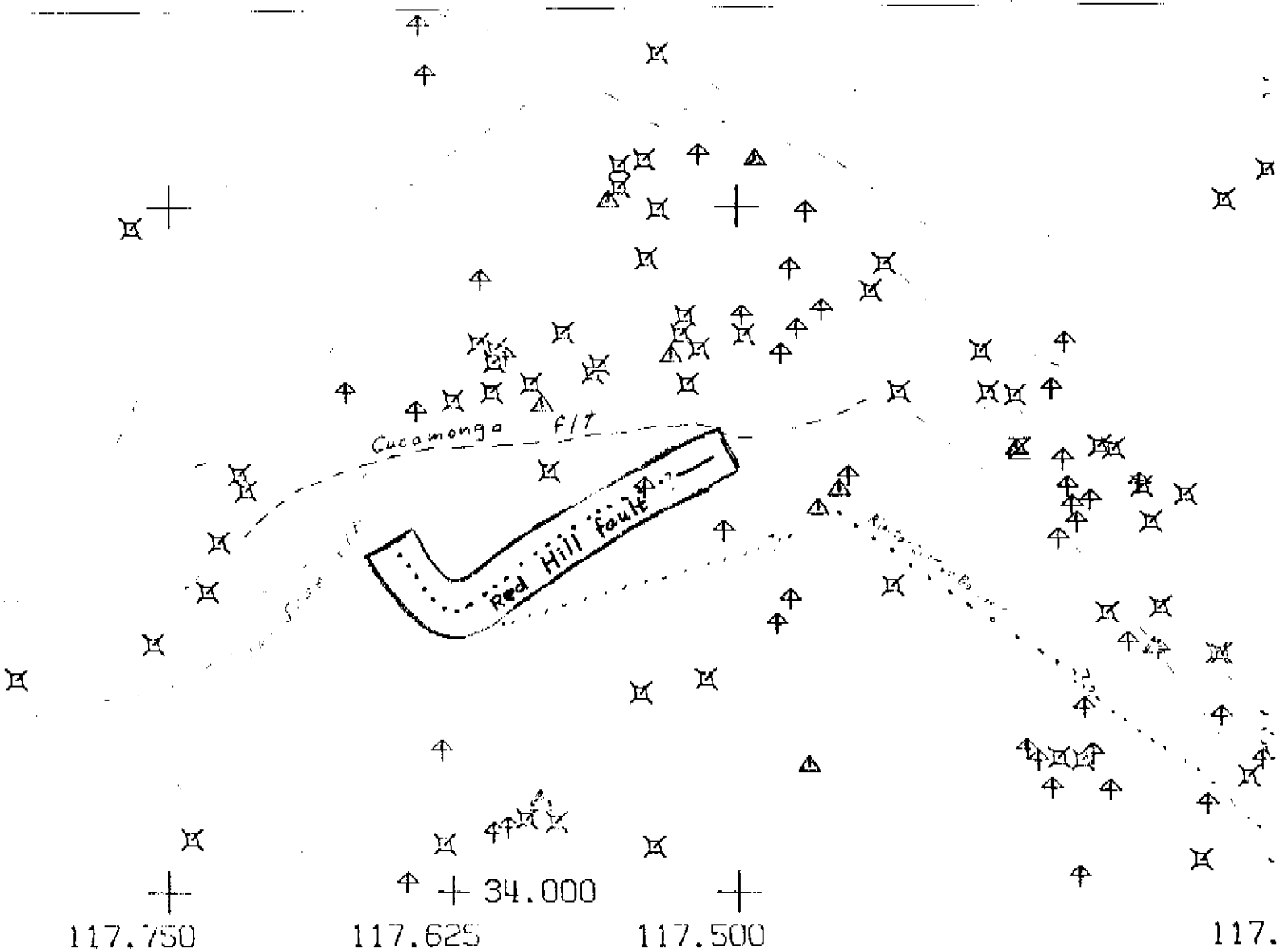


Figure 3. Seismicity map (modified from [illegible])

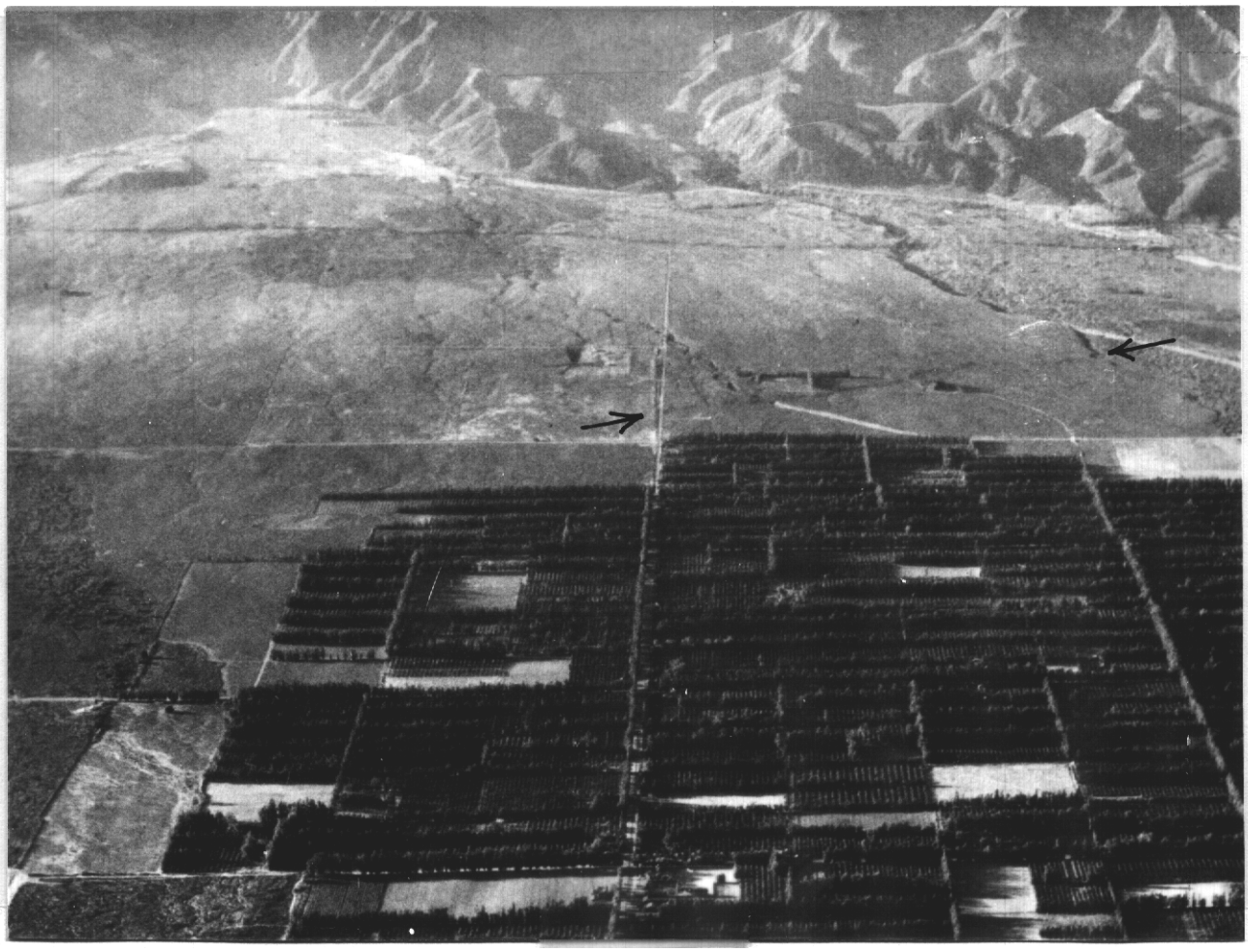


Figure 4. View of scarp at northeastern and of Red Hill fault, looking north over Etiwanda area. Arrows show endpoints of the scarp. The Cucamonga scarp extends entirely across the scene in the background. Photo from Burnham (1953, p. 56, figure 9).